

CHIHUAHUAN DESERT ECOREGION

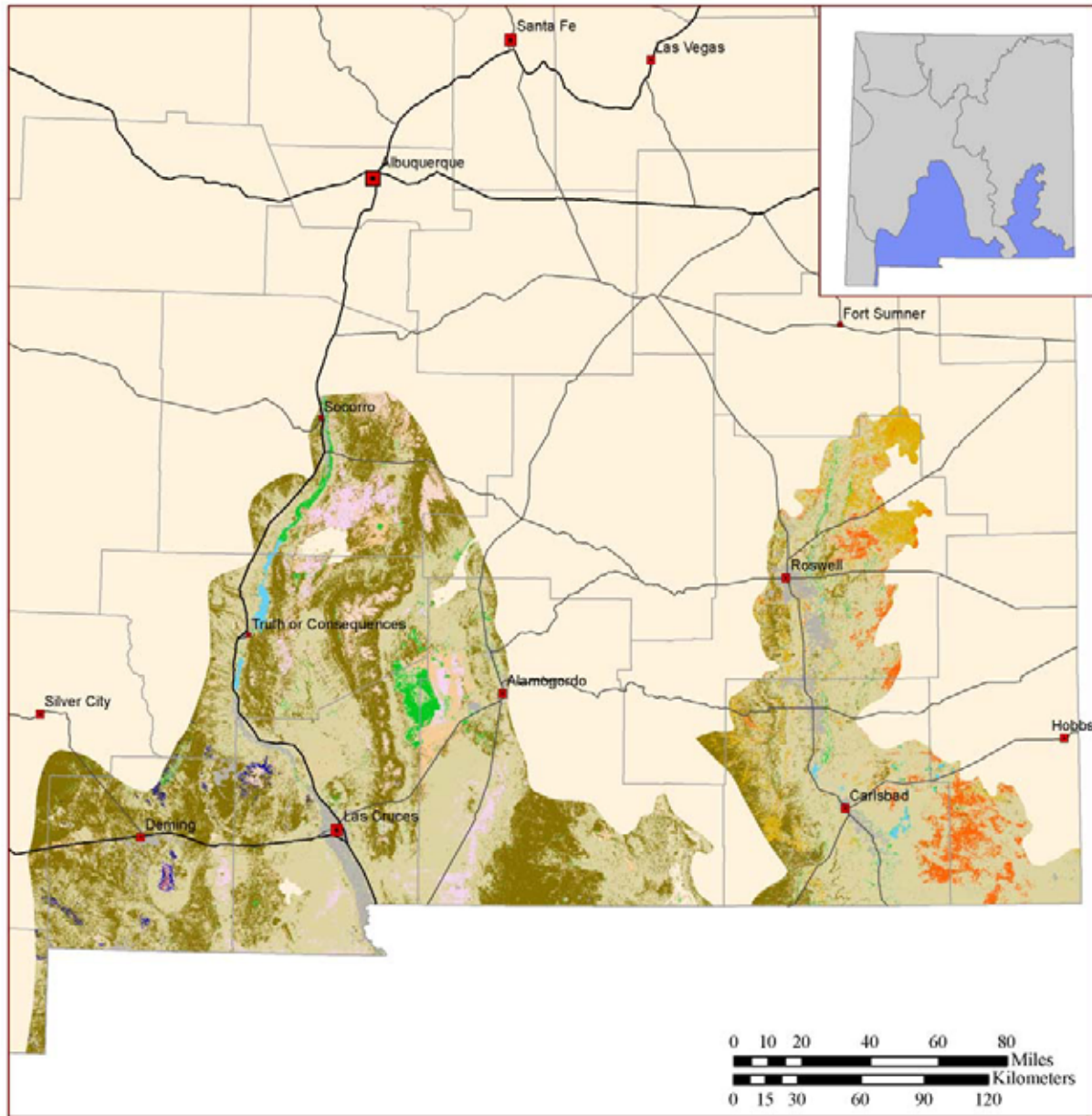
The Chihuahuan Desert Ecoregion is dominated by Chihuahuan semi-desert grasslands and desert scrub vegetation (Bell *et al.* 2004). In New Mexico, this ecoregion encompasses approximately 15.2 million ac (6.1 million ha) in Luna, Dona Ana, Sierra, and Eddy counties, and portions of Socorro, Lincoln, Otero, Chaves, and Lea counties. Approximately 66% of the Chihuahuan Desert Ecoregion in New Mexico is privately managed. Federal agencies (primarily Bureau of Land Management and Department of Defense) administer approximately 26% while state agencies administer approximately 8% of the ecoregion (Thompson *et al.* 1996).

Two key terrestrial habitat types were identified in this ecoregion, Chihuahuan Semi-desert Grasslands, and the Western Great Plains Sandhill Sagebrush Shrubland (Fig. 5-3). Grassland habitats in the ecoregion have been identified and prioritized for conservation by the World Wildlife Fund (Dinerstein *et al.* 2000). Semi-desert grasslands are recognized for their regional biological value, especially their importance to grassland birds (Biodiversity Support Program *et al.* 1995). Grassland bird populations have been declining across the North American continent for over the last 50 years (Knopf 1994, Peterjohn and Sauer 1999, Vickery and Herkert 2001). The aplomado falcon (*Falco femoralis*) is a grassland adapted bird that was once considered extirpated from the southwest. However, recent sightings of falcons, a successful breeding pair, and potential reintroductions in New Mexico increases optimism for the reestablishment of this bird into historic habitats. Nevertheless, grassland conservation is paramount in conserving aplomado falcons and other grassland birds in the Chihuahuan Desert (Young *et al.* 2004). The Western Great Plains Sandhill Sagebrush Shrubland hosts a variety of resident native wildlife. The lesser prairie-chicken (*Tympanuchus pallidicinctus*), and sand dune lizard (*Sceloporus arenicolus*) have received much attention in this habitat type. Conservation efforts directed at the lesser prairie-chicken are excellent examples of collaborative efforts between federal, state and private land managers and environmental organizations.

Reptile collection and trade in the Chihuahuan Desert Ecoregion is factor that influences the integrity of reptile and amphibian populations. Reptile and amphibian biodiversity in the Chihuahuan Desert Ecoregion alone consists of approximately 217 species (Fitzgerald *et al.* 2004). In the United States portion of the Chihuahuan Desert Ecoregion, approximately 120 reptile and amphibian species are subject to domestic and international trade. Although collection for the commercial trade may impact these populations, the magnitude of this impact has not been thoroughly investigated and is poorly understood.

Species of Greatest Conservation Need

Of all the ecoregions in New Mexico, the Chihuahuan Desert Ecoregion was the third highest in regard to the number of Species of Greatest Conservation Need (SGCN). Excluding arthropods other than crustaceans, 57 SGCN have been identified in this ecoregion. Chihuahuan Semi-desert grasslands hosts 55 SGCN, and the Western Great Plains Sandhill Sagebrush Shrubland hosts 14 SGCN (Table 5-5). Thirty-six species (63%) were classified as vulnerable, imperiled, or critically imperiled both statewide and nationally. Ten species (18%) are nationally secure, but are considered vulnerable, imperiled, or critically imperiled in New Mexico, and 11 species (19%) are secure both statewide and nationally.



- | Key Terrestrial Habitats | | Adjacent Landcover | |
|--------------------------|--|--------------------|------------------------------------|
| * | Chihuahuan Semi-Desert Grassland | | Active and Stabilized Dunes |
| | Inter-Mountain Basins Big Sagebrush Shrubland | | Agriculture and Developed |
| | Madrean Encinal | | Open water |
| | Madrean Pine-Oak Conifer-Oak Forest and Woodland | | Pinyon-Juniper/Juniper Savanna |
| | Riparian | | Recently Disturbed |
| | Rocky Mountain Alpine-Montane Wet Meadow | | Rocky Mountain Forest and Woodland |
| | Rocky Mountain Montane Mixed Conifer Forest and Woodland | | Scrub and Shrubland |
| * | Western Great Plains Sandhill Shrubland | | Steppe and Grassland |
| | Western Great Plains Shortgrass Prairie | | |

The source of data is the Southwest Regional Gap Analysis Project (SWReGAP). For information regarding methods, results, and data accuracy, refer to <http://fws-nmcfwra.nmsu.edu/swregap/>.

Figure 5-3. Key terrestrial habitats in the Chihuahuan Desert Ecoregion in New Mexico. Adjacent land cover types are given to provide an indication of vegetation surrounding key habitats. Key habitats are designated with an asterisk (*).

Table 5-5. Species of Greatest Conservation Need in the Chihuahuan Desert Ecoregion in New Mexico.

Common Name	Chihuahuan Semi-Desert Grasslands	Western Great Plains Sandhill Sagebrush Shrubland
<i>Birds</i>		
Bald Eagle	X	
Northern Harrier	X	
Ferruginous Hawk	X	X
Golden Eagle	X	
Aplomado Falcon	X	
Lesser Prairie-Chicken		X
Montezuma Quail	X	
Scaled Quail	X	
Sandhill Crane	X	
Mourning Dove	X	X
Common Ground-Dove	X	
Burrowing Owl	X	X
Loggerhead Shrike	X	X
Gray Vireo	X	
Sage Thrasher	X	
Bendire's Thrasher	X	
Sprague's Pipit	X	
Botteri's Sparrow	X	
Baird's Sparrow	X	
Grasshopper Sparrow	X	
Varied Bunting	X	
Hooded Oriole	X	
<i>Mammals</i>		
Mexican Long-Tongued Bat	X	
Lesser Long-Nosed Bat	X	
Arizona Myotis Bat	X	
Pocketed Free-Tailed Bat	X	
White-sided Jack Rabbit	X	
Black-tailed Prairie Dog	X	X
Northern Pygmy Mouse	X	
Yellow-Nosed Cotton Rat	X	
Mexican Gray Wolf	X	
Swift Fox	X	X
Mule Deer	X	X
Coues' White-Tailed Deer	X	
Desert Bighorn Sheep	X	
<i>Amphibians</i>		
Great Plains Narrowmouth Toad	X	
Tiger Salamander	X	X
<i>Reptiles</i>		
Ornate Box Turtle	X	

Table 5-5 Cont.

Common Name	Chihuahuan Semi-Desert Grasslands	Western Great Plains Sandhill Sagebrush Shrubland
<i>Reptiles cont.</i>		
Collared Lizard	X	X
Sand Dune Lizard		X
Bunch Grass Lizard	X	
Texas Banded Gecko	X	
Gray-Checkered Whiptail	X	
Gray-Banded Kingsnake	X	
Milk Snake	X	X
Western Diamondback Rattlesnake	X	X
Desert Massasauga	X	X
<i>Molluscs</i>		
New Mexico Ramshorn Snail	X	
Three-Toothed Column Snail	X	
Distorted Metastoma Snail	X	
Whitewashed Radabotus Snail	X	
Woodlandsnail	X	
Organ Mountain Talussnail	X	
Franklin Mountain Talussnail	X	
Dona Ana Talussnail	X	
San Luis Mountains Talussnail	X	
Northern Treeband Snail	X	

Conservation status codes (abundance estimates) for each SGCN are provided in Appendix H. Additional conservation concerns for taxa associated with this ecoregion are addressed in 1) Statewide Distributed Ephemeral Habitats and Perennial Tanks, 2) Statewide Distributed Riparian Habitats, or 3) Watersheds with aquatic key habitats sections.

Chihuahuan Semi-Desert Grasslands

Habitat Condition

Chihuahuan semi-desert grasslands are found throughout the Chihuahuan Desert Ecoregion. As with other grassland communities in the western United States, this habitat type experienced a marked shift from perennial grassland to shrub-dominated desert scrubland around the mid-1800s (Barnes 1936, Buffington and Herbel 1965, Branson 1985, Archer 1989). The exact cause of this shift is debated, but excessive livestock grazing, climatic change, and fire suppression have been implicated (Fredrickson *et al.* 1998). In turn, grassland conversion and human-caused fragmentation have caused increased runoff and erosion, decreased biological diversity through isolation and reduced carrying capacity (Saunders *et al.* 1991), shifts in avian species assemblages, increased invasion by non-native species, and decreased livestock and wildlife forage (Branson 1985, Vickery *et al.* 1999, Desmond *et al.* 2005). Today, portions of the type appear to be undergoing additional desertification (Asner 2005).

Problems Affecting Habitat or Species

Biodiversity in Chihuahuan semi-desert grasslands is influenced by habitat conversion factors and non-consumptive and consumptive resources uses. Dinerstein *et al.* (2000) also reported that livestock grazing, fire suppression, and urban development were factors leading to loss of biodiversity in the northern Chihuahuan Desert.

Grazing Practices

Livestock grazing has economic and cultural values that are important to individuals, and communities in the Chihuahuan Desert. Impacts of livestock grazing on rangeland wildlife in the Chihuahuan Desert are largely dependent on the grazing management practices used. Domestic livestock and wildlife grazing practices that reduce the ability of the land to sustain long term plant and animal production (Wilson and MacLeod 1991), may lead to the loss of grassland cover, mortality of plant species, and increased erosion. Further, improper grazing practices and increased agriculture production may lead to habitat fragmentation and loss by promoting conditions favorable for shrub encroachment and through increased infrastructure development, such as roads and fences (Dinerstein *et al.* 2000). These land management activities are compounded by extended drought periods and altered hydrological functions.

Fire Regimes

Altered fire regimes, resulting from both fire suppression and the removal of fine fuels by domestic grazers and wildlife may also promote the establishment of both woody vegetation and introduced non-native species. However, the extent to which fire occurred in southwestern grasslands varied geographically and is related to climatic variables such as seasonal and annual rainfall and physiographic variables such as elevation, slope and aspect (Archer 1994). Fire may have been rare in desert grasslands and limited in extent due to low biomass and a lack of continuity in fine fuels (Hastings and Turner 1965, York and Dick-Peddie 1969).

Development and Exploration

Human population is increasing in the Chihuahuan desert in southern New Mexico. With this increase in population, urban, commercial, and rural development has increased. These developments and subdivisions contribute greatly to the loss of native vegetation and increased erosion through soil compaction and runoff concentration. In addition, Chihuahuan semi-desert grasslands in the vicinity of Otero Mesa and Crow Flats are currently being explored for natural gas. Within the same areas, activities related to drilling and pumping of deep groundwater for El Paso and Las Cruces are also being proposed. These activities may ultimately cause further habitat fragmentation and loss through landscape conversion (clearing), roads, and increased vehicular traffic (Dinerstein *et al.* 2000).

Off-Road Vehicles

Recreational off-road vehicle use has also increased in the Chihuahuan semi-desert grasslands. These activities are found in Dona Ana and Socorro counties where several organized events are held each year. While the impacts of these activities on the Chihuahuan semi-desert grasslands are poorly understood, increased off-road vehicle use may negatively impact wildlife by destroying and fragmenting habitat, direct mortality of wildlife, or altered behavior through stress and disturbance (Busack and Bury 1974, Brattstrom and Bondello 1983).

Military and Borderland Security Activities

White Sands Missile Range and Fort Bliss Military Reservation both host extensive areas of Chihuahuan semi-desert grasslands. Military maneuvers and infrastructure development may destroy and fragment existing grassland habitats. Border security efforts and associated road building and road improvement activities are occurring throughout the US/Mexico borderlands region to intercept drug shipments, illegal immigrants, and stop other unauthorized activities (US Department of Justice, Immigration and Naturalization Service 2000). Increased road building and traffic in the borderlands region causes additional habitat loss and fragmentation, reduces effective (useable) habitat for wildlife populations, increases roadkill mortality, poaching, illegal collecting of wildlife and causes general habitat destruction (Forman *et al.* 2003).

Non-Native Species

Many ecologists have acknowledged the problems caused by invasion of non-native species into communities or ecosystems and the associated negative effects on global patterns of biodiversity (Stohlgren *et al.* 1999). Once established, invasive species have the ability to displace native plant and animal species (including threatened and endangered species), disrupt nutrient and fire cycles, and alter the character of the community by enhancing additional invasions (Cox 1999, Deloach *et al.* 2000, Zavaleta *et al.* 2001, Osborn *et al.* 2002). Little is known about the extent of invasive species in Chihuahuan semi-desert grasslands. As such, the development of early detection protocols, and estimators of vectors and pathways of potential invasive species may inform conservation strategies related to invasive species.

Diseases and Pathogens

A total of nine cases of chronic wasting disease have been confirmed in New Mexico as of September 2005. All were mule deer (*Odocoileus hemionus*) located in the Organ Mountains east of Las Cruces. Two mule deer subjected to tonsillar biopsies and released in December of 2004 in southern New Mexico as part of a research project were later found to be positive for chronic wasting disease. Additional information on the extent and risk of chronic wasting disease is necessary to understand the extent of this problem.

Information Gaps

Although there is a large body of literature on the ecology of the Chihuahuan semi-desert grasslands, there are numerous information gaps that limit our ability to make conservation decisions. Information gaps are outlined below.

- The intensity, scale, extent, and causes of grassland fragmentation in the Chihuahuan Desert are unknown.
- The response of SGCN to human disturbances is poorly understood.
- The effects of habitat fragmentation on SGCN are unknown.
- Environmental conditions or thresholds that limit populations of SGCN are poorly understood.

- Methods to identify early detection landscape degradation attributes that would inform land managers of when grasslands were approaching transitional thresholds are needed, to alleviate the need for expensive restoration projects.
- Specific information on viable approaches to restore semi-desert grasslands to functional mosaics is lacking.
- The extent to which invasive species may alter semi-desert grasslands and limit populations of SGCN is unknown.
- The full extent in which border patrol activities or military maneuvers alters semi-desert grasslands and limits populations of SGCN is unclear.
- Information is needed on grazing management practices that produce sustainable levels, composition, and structure of native grasses.
- The extent to which off-road vehicle use is impacting Chihuahuan semi-desert grassland SGCN populations is unknown.
- Our understanding of the role of fire in sustaining the Chihuahuan semi-desert grasslands and appropriate fire management protocols is poor.
- Short and long-term affects of land management practices or uses (such as energy exploration and development, grazing regimes, invasive species and shrub encroachment management) are unclear. Availability and distribution of this information would allow land managers to make more informed conservation decisions.
- The extent and distribution of chronic wasting disease is currently poorly understood.

Research, Survey, and Monitoring Needs

Research, survey, and monitoring needs for the Chihuahuan semi-desert grasslands are primarily derived from our perception of factors that influence the integrity of semi-desert grasslands and associated information gaps. Research, survey, and monitoring needs include:

- Estimate the areal extent, fragmentation, and structural characteristics of Chihuahuan semi-desert grasslands to provide greater predictive power and applicability to an ecosystem management approach.
- Research is needed on the extent to which land use activities (such as livestock grazing timing, intensity, and duration; human development; gas, oil, and water exploration; off-road vehicle use; military and borderland security activities; and exotic species invasions) fragment and alter habitats in relation to patch size, edge effect, and use by wildlife. This information is important in understanding how different land use intensities and frequencies of disturbances affect SGCN.

- Conduct research to enhance our knowledge of vertebrate and invertebrate community structures, fundamental natural history requirements, and ecological relationships in Chihuahuan semi-desert grasslands. Although there is growing body of ecological research on this semi-desert grasslands, life history and habitat needs of most of the SGCN and their use of this semi-desert grasslands are poorly understood.
- Examine how global and regional climate change coupled with resource uses will affect community and ecosystem-level dynamics in the Chihuahuan semi-desert grasslands.
- Investigate hydrologic relationships in the Chihuahuan semi-desert grasslands to provide a better understanding of interception, transpiration, and infiltration processes for sustainable watershed conservation and management practices.
- Given that this habitat type has experienced a shift from perennial grassland to shrub-dominated desert scrubland (Buffington and Herbel 1965, Archer 1989), the identification of early detection attributes that informs land managers of when grasslands habitats are approaching other community types is needed. In addition, cost effective approaches to restore semi-desert grasslands to functional mosaics need to be investigated.
- Consistent rangeland health and condition descriptions or protocols need to be developed across the state, region, and nation (National Research Council 1994). These descriptions and protocols would facilitate land management decisions by establishing standardized indicators and reference points.
- Investigate invasive species early detection protocols, and estimate vectors and pathways of potential invasive species.
- SGCN populations and their habitats should be estimated and monitored (where possible) to determine long-term population trends and to correlate population trends to ecosystem dynamics and habitat changes.
- Investigate the roll of natural fire and prescribed fire in maintaining grassland habitats.
- Research is needed on the extent of chronic wasting disease and the long-term effects of this disease on SGCN.

Desired Future Outcomes

Desired future outcomes for the Chihuahuan semi-desert grasslands include:

- Chihuahuan semi-desert grasslands persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land management uses with reduced resource use conflicts.

- Ecological conditions necessary to sustain viable populations of the SGCN in semi-desert grassland habitats are established and garner wide public support.
- Working groups have been established composed of county, municipal, state, and federal land management agencies, and public landowners dedicated to prioritizing and addressing conservation and habitat issues at the grassland-urban interface.
- Partnerships have been established to identify and implement adequate funding for conservation planning; education, and technical, reclamation, survey, or research projects that ensure the future integrity and functionality of semi-desert grasslands for SGCN and resource extraction needs.
- Consistent grassland reclamation standards are established that ensure future habitat integrity and functionality and are adopted by private landowners, counties, municipalities, and federal and state land management agencies.
- Land management plans for federal and state lands include sustainable grazing practices that are fully implemented and enforced.
- A fully funded comprehensive state-wide noxious weed control planning committee and program is established. Colonization of noxious weed species is stopped and extant weed populations are controlled or eliminated.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Work with land management agencies, private land managers, and the agriculture industry to identify and promote grazing systems on rangelands that ensure long-term ecological sustainability and integrity and are cost effective for livestock interests. Such practices may include collaborative development of grazing management plans, altering domestic and wildlife stocking rates, time and use, and distribution where forage availability is inadequate, and promoting "grass banking" opportunities that allow degraded rangelands to recover.
2. Work with public and private land managers to reduce shrub encroachment in Chihuahuan semi-desert grasslands habitats important to SGCN. Implementation of this conservation action may include chemical or mechanical manipulation, reseeding with native grasses, or reduction of processes that promote shrub encroachment.

3. Work with federal, state, private organizations, research institutions, and universities to design and implement projects outlined in the Research, Survey, and Monitoring Needs or Information Gaps section outlined above.
4. Work with public and private land managers and the energy industry to encourage energy development in a manner that preserves the integrity and functionality of Chihuahuan semi-desert grasslands and restores disturbed sites.
5. Form partnerships with effected communities and federal land management agencies to facilitate and encourage maintenance and restoration of Chihuahuan semi-desert grasslands.
6. Collaborate with federal and state agencies to designate areas for off-road vehicle use that avoid disturbance to SGCN or their habitats and discover ways to mitigate such disturbance where it currently occurs.
7. Collaborate with federal and state land management agencies and other publics to identify legislative actions, land acquisition and easement protection that will conserve the Chihuahuan semi-desert grasslands.
8. Work with federal, state, and private organizations to develop public education projects that increase awareness and understanding of the fragility of Chihuahuan semi-desert grasslands and their importance to a wide array of species.

Western Great Plains Sandhill Sagebrush Shrublands

Habitat Condition

The Western Great Plains Sandhill Sagebrush Shrublands are a mosaic of hummock and coppice dunes dominated by sand sage (*Artemisia filifolia*) and/or shinnery oak (*Quercus havardii*) with a mixed grass and tallgrass composition. The habitat type is found in the Chihuahuan Desert and the Southern Shortgrass Prairie Ecoregions. In the Chihuahuan Desert Ecoregion, sites dominated by sand sage and purple pea (*Dalea scoparia*) are largely found in central New Mexico adjacent to the middle Rio Grande corridor. Grasses in these sites consist of Indian ricegrass (*Oryzopsis hymenoides*), little bluestem (*Andropogon scoparium*), and sand dropseed (*Sporobolus cryptandrus*).

The Western Great Plains Sandhill Sagebrush Shrublands habitat is considered a climax vegetation (Rosiere 2000) although, there is anecdotal evidence suggesting that the dense stands of shinnery-oak and sand sage on the high plains of eastern New Mexico are a result of intense grazing pressure. Soils in this habitat type are typically deep and well drained with surface textures consisting of aeolian fine sands or loamy aeolian fine sands. These soils often extend to a depth of 60 in (152 cm) or more. Water holding capacity is low, and the soils are highly erodible. When organic residues and vegetative cover are removed, landscapes typically are converted to unstabilized dunes (Natural Resource Conservation Service 1997; Ecological Site Description, Sandhills). Soils in dune areas are well drained and grade to a shallower calcic

hardpan overlaid by a shallow sand at the southwestern and southern boundaries of this ecological site. Shallow soil sites are typically dominated by buffalograss (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*) and threeleaf sumac (*Rhus trilobata*) or littleleaf sumac (*Rhus microphylla*).

Continuous year-round or season-long summer grazing (April through October) have reduced the once dominant tall- and mixed cool season grass species including New Mexico feathergrass (*Stipa neomexicana*), needle and thread grass (*Hesperostipa comata*), and Indian ricegrass. Today, large portions of the type are dominated by sand dropseed, sand sage, soaptree yucca (*Yucca elata*), and threeawn species (*Aristida* spp.) with lower cover and productivity values (Natural Resource Conservation Service 1997; Ecological Site Description, Deep Sand). Season-long summer use by livestock has also reduced both the amount of forbs and warm season grasses found in this habitat type and their concomitant production of organic litter on the soil surface. This reduction has increased the sand dunes' vulnerability to wind erosion and blowouts. In the northern reaches of the Chihuahuan Desert Ecoregion, Rosiere (2000) noted that sand sage has increased on overgrazed ranges and abandoned farmlands to densities similar to those of the Intermountain West's big sagebrush steppe. However, shrub components of this type remain important in terms of nutrient cycling and ecosystem function where sagebrush, shinnery oak, and subdominant shrubs trap and accumulate nutrients around their bases forming "islands of fertility" (Schlesinger and Pilmanis 1998). This accretion of organic matter and nutrients is especially important to insects and ultimately to rodents, herpetofauna, and birds that consume them (Whitford *et al.* 1998).

Problems Affecting Habitat or Species

Factors that are most likely to influence SGCN and the Western Great Plains Sandhill Sagebrush Shrublands in the Chihuahuan Desert Ecoregion are habitat conversion factors, abiotic resource use, and consumptive uses. Since the early 1950s, this habitat has been altered in the more southerly areas of the High Plains by agricultural conversion and practices, oil and gas development, excessive livestock grazing, and brush and weed control (through the use of herbicides) (Jackson and DeArment 1963, Hunt and Best 2004). These factors have contributed to the decrease in habitat and increase in fragmentation for lesser prairie-chickens and sand dune lizards.

Agriculture and Livestock Production

Improper grazing practices (those that reduce long-term plant and animal productivity) and increased agriculture production in the Western Great Plains Sandhill Sagebrush Shrublands may lead to habitat fragmentation and loss by promoting conditions favorable for shrub encroachment and through increased infrastructure development, such as roads, fences, subdivisions, agricultural lands (Dinerstein *et al.* 2000). The effects of these land management activities are compounded by extended drought periods and altered hydrological functions in the Chihuahuan Desert. Altered fire regimes, resulting from both fire suppression and the removal of fine fuels by domestic grazers and wildlife, also promote the establishment of both woody vegetation and introduced non-native species.

Development and Exploration

Oil and gas exploration and extraction activities typically have localized effects on sand dune lizards' populations. Sias and Snell (1998) reported a negative relationship between well density and abundance of sand dune lizards. Oil and gas development activities reduced populations approximately 40% when compared to control areas that were approximately 200 m distant from a pad (Sias and Snell 1996). In addition to low population numbers, oil and gas development activities may cause further habitat fragmentation and loss through landscape conversion (clearing), roads, and increased vehicular traffic (Dinerstein *et al.* 2000).

Invasive and Non-Native Species

Soil Bank programs of the 1950s and 1960s also made use of non-native lovegrasses (*Eragrostis curvula*, *E. lehmannii*) to stabilize topsoil. In the mid-1980s, the Conservation Reserve Program (CRP) was initiated to reduce the number of cultivated grain fields. At this time, lovegrasses were again planted. Older established plantings of weeping lovegrass (*E. curvula*) are particularly persistent if grazed or burned. In some instances, range fires in these established grass stands have become more frequent, further reinforcing the persistence of this fire-adapted non-native grass.

Chemical Shrub Control

Shinnery oak is a management concern when it grows in dense stands, particularly where it comprises 80% of the annual plant production and competes with native grasses and forbs for water and nutrients (Pettit 1986). Shrub control in the 1980s made use of the herbicide tebuthiuron and nearly 40,500 ha (100,000 ac) of BLM lands in southeastern New Mexico were treated to reduce shinnery oak and to increase grass production for livestock grazing (Massey 2001).

Control of shinnery oak affects lesser prairie-chickens and sand dune lizards. Lesser prairie-chickens may use stands of dense shinnery oak; however, they prefer areas dominated by perennial mid and tall-grass species (Cannon and Knopf 1981). While Johnson (2000) found a greater concentration of lesser prairie-chickens nesting in areas that were not treated with herbicide, Olawsky and Smith (1991) reported similar densities of lesser prairie-chicken on herbicide treated and untreated areas. The sand dune lizard appears to be confined to areas of active sand dunes vegetated by shinnery oak and their peripheries where the uneven sandy terrain and wind-eroded blowouts meet their habitat requirements (Degenhardt and Jones 1972, Degenhardt and Sena 1976, Sena 1985, Snell *et al.* 1994, NMDGF 1996). Control of shinnery oak by tebuthiuron in the Mescalero Sands, Chaves County, New Mexico indicated reductions between 70-94% in the number of sand dune lizards in treated pastures. In many sites, lizards were not observed in the treated pastures despite suitable populations in adjacent untreated pastures. Snell *et al.* (1993, 1994) and Gorum *et al.* (1995) noted that populations have declined since the initiation of tebuthiuron treatments and that following treatment, sand dune lizard habitat can be considered either lost or greatly reduced in quality.

The persistence of herbicide and other environmental contaminants and their effects on fish and wildlife have been reviewed by Schmitt and Bunck (1995) and Glaser (1995). However, the magnitude and effects of herbicide use in the Western Great Plains Sandhill Sagebrush Shrublands has not been well assessed (Mac *et al.* 1998).

Off-Road Vehicles

The frequency and intensity of recreational off-road vehicle use has also increased in the Western Great Plains Sandhill Sagebrush Shrublands; however, the extent of these activities is unknown. While the impacts of these activities on the sand sagebrush shrublands are poorly understood, increased off-road vehicles may negatively impact wildlife by destroying and fragmenting habitat, direct mortality of wildlife, or altered behavior through stress and disturbance (Busack and Bury 1974, Brattstrom and Bondello 1983).

Information Gaps

There is little literature on the ecology of the Western Great Plains Sandhill Sagebrush Shrublands. Current literature is primarily based on habitat needs for lesser prairie-chickens and sand dune lizards. Information gaps that limit our ability to make informed conservation decisions are outlined below.

- The intensity, scale, extent, and causes of Western Great Plains Sandhill Sagebrush Shrublands fragmentation are unknown.
- Little is known on grazing management practices that maintain appropriate levels and compositions of native grasses in this habitat type.
- The response of SGCN to human disturbances is poorly understood.
- The effects of habitat fragmentation on SGCN are unknown.
- Little is known on the environmental conditions or thresholds that limit populations of SGCN.
- The extent to which invasive and non-native species alter Western Great Plains Sandhill Sagebrush Shrublands and limit populations of SGCN is unknown.
- Short and long-term effects of land management practices or uses (such as energy exploration and development, grazing regimes, invasive species and vegetation management) are unclear. Availability and distribution of this information would allow land managers to make more informed conservation decisions.
- The extent to which off-road vehicle use is impacting Western Great Plains Sandhill Sagebrush Shrublands SGCN populations is unknown.

Research, Survey, and Monitoring Needs

Research, survey, and monitoring needs for the Western Great Plains Sandhill Sagebrush Shrublands are primarily derived from our perception of factors that influence the integrity of this habitat type and associated information gaps. Research, survey, and monitoring needs that enhance our ability to make informed conservation decisions are outlined below.

- Investigate the extent to which land use activities (such as livestock grazing timing, intensity, and duration; human development; gas, oil, and water exploration; off-road vehicle use; and non-native species invasions) fragment and alter habitats in relation to patch size, edge effect, and use by SGCN. This information is important in understanding how different land use intensities and frequencies of disturbance effect SGCN.
- Conduct research to enhance our knowledge of vertebrate and invertebrate community structures, fundamental natural history requirements, and ecological relationships in the Western Great Plains Sandhill Sagebrush Shrublands. Life history and habitat needs of most of the SGCN and their use of this habitat type are poorly understood.
- Examine how global and regional climate change coupled with resource uses affect community and ecosystem-level dynamics in the Western Great Plains Sandhill Sagebrush Shrublands.
- Investigate the use of tebuthiuron for reducing shinnery oak cover and SGCN response to spatially diverse applications of herbicides with respect to SGCN habitat requirements.
- Identify thresholds of shinnery oak and/or sand sage cover or density at which reproduction and brood success of lesser prairie-chickens and sand dune lizards are reduced or eliminated.
- Investigate how natural fire regimes and the role of fire in the Western Great Plains Sandhill Sagebrush Shrublands can help in restoring and maintaining shinnery oak habitats and can be used as a shrub control methodology.
- Identify grazing management practices that maintain appropriate levels and compositions of native grasses within shinnery oak habitat types.
- Explore the influence of CRP on landscape structure and SGCN habitat.
- Investigate how habitat fragmentation by oil and gas development and the concomitant effects on the size and connectivity of habitat patches affects population energetics and persistence of SGCN.
- Identify nationally standardized indicators that could be used for inventory and monitoring the health of the Western Great Plains Sandhill Sagebrush Shrublands.

Desired Future Outcomes

Desired future outcomes for the Western Great Plains Sandhill Sagebrush Shrublands include:

- Western Great Plains Sandhill Sagebrush Shrublands persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land management uses with reduced resource use conflicts.

- Reclamation standards that ensure habitat integrity and function are established and implemented for land use practices that alter habitat condition.
- Partnerships are established with NRCS and landowners to establish and implement ecologically sound restoration of CRP and abandoned croplands to native shrub/grasslands.
- Land management plans for federal and state lands include sustainable grazing practices that are fully implemented and enforced.
- Natural fire cycles are restored in this habitat.
- Herbicide treatments optimize structurally diverse habitats for wildlife and livestock.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Work with land management agencies, private land managers, and the agriculture industry to identify and promote grazing systems on rangelands that ensure long-term ecological sustainability and integrity and are cost effective for livestock interests.
2. Collaborate with federal and state agencies, and private landowners in restoration of the Western Great Plains Sandhill Sagebrush Shrublands. Restoration actions may include: mitigation and reduction of impacts related to oil and gas development; restoration and return of abandoned croplands to native shrub/grassland; managed sustainable grazing on public lands that accounts for SGCN habitat concerns; and active research programs on the use of tebuthiuron coupled with controlled burns for reducing shinnery oak cover.
3. Work with federal and state agencies, private landowners, and oil and gas development companies to rehabilitate abandoned well pads and access roads. Rehabilitation efforts may include the removal of caliche and/or reseeding with a mix of native species with supplemental watering.
4. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and the Western Great Plains Sandhill Sagebrush Shrublands outlined in the Research, Survey, and Monitoring Needs section.

5. Work with federal, state, and private agencies, NGOs, and institutions to create financial incentives for habitat maintenance and improvement on private lands and conservation easements.
6. Work with willing landowners to increase the size and connectivity of designated prairie-chicken areas.
7. Work with federal, state, and private agencies, institutions and landowners to provide financial incentives to maintain tracts of native vegetation, as an alternative to converting land to agriculture or urban development.
8. Collaborate with federal and state agencies to designate areas for off-road vehicle activities that avoid disturbance to SGCN or their habitats and to discover ways to mitigate such disturbance where it currently occurs.
9. Encourage Conservation Reserve Program land managers to promote use of native seed mixes for soil stabilization and increased value to SGCN.
10. Encourage land managers to establish and maintain a diverse mosaic of interspersed patches of shinnery oak and residual bunchgrasses.
11. Work with federal, state, and private agencies and institutions in developing an education and public awareness program that emphasizes the fragility of this habitat type and its importance to a wide array of species.